The Radioactive Mass Separator at INL's Materials & Fuels Complex is part of a suite of powerful new tools, technologies and capabilities that are enabling the next generation of nuclear energy advances.

Suite of new capabilities makes Idaho a 'one-stop shop' for nuclear energy research

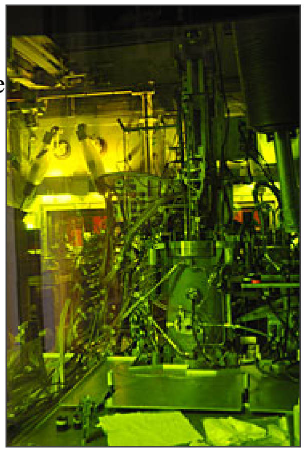
By Alexandra Branscombe and Joseph Campbell, *INL Communications & Governmental Affairs*

In the middle of the Idaho desert resides a specialized nuclear research complex where scientists and engineers are leading cutting-edge research supporting the nation's nuclear energy and national security missions.

At Idaho National Laboratory's Materials and Fuels Complex, new and unique nuclear research capabilities are part of the daily routine as scientists adapt powerful new tools and technologies to handle some of the heaviest elements on the periodic table. The MFC is home to a history of research underlying what the world knows today about nuclear energy and nuclear reactors. Now, a suite of new capabilities is empowering the next generation of nuclear energy advances.

Below is a snapshot of several new nuclear research capabilities added or demonstrated at MFC in the past year.

Fuel Accident Condition Simulator furnace
What's new: INL scientists can now test how advanced nuclear fuels perform under accident conditions with the help of a new furnace at the Hot Fuel Examination Facility. The Fuel Accident Condition Simulator (FACS) furnace completed its first 15-day extreme condition simulation test on a fuel sample. The recent simulation supports research for the Very High Temperature Gas-Cooled Reactor (VHTR), a next-generation nuclear reactor design that uses a particle fuel concept.



The Fuel Accident Condition Simulator (FACS) furnace can test how advanced nuclear fuels perform under accident conditions.

Why it's important: The furnace gives INL scientists the ability to understand how new fuels will withstand the extreme temperatures if a reactor loses cooling ability. Researchers at the facility heat fuels to failure in a controlled environment to better understand the fuel's behavior in the event of an accident. Analysis of fission products from these tests provides important information about when certain isotopes are released, information critical to verifying the performance of different fuel forms at high temperatures. Such knowledge helps define the safe working parameters of more efficient power reactors in the future.

The next step: The first safety tests focused on a fuel specimen for the Advanced Gas Reactor project that had been irradiated at INL's Advanced Test Reactor (ATR). The specimens showed exceptional performance in early analysis and will continue to be tested for the rest of 2013. A new set of samples is scheduled for testing during 2014.

Purifying americium
What's new: A team of researchers, engineers, facility operators and other support staff successfully distilled americium metal using INL-designed and -built equipment to remove impurities from samples provided by Lawrence Livermore National Laboratory.

How it's unique: No other Department of Energy laboratory has demonstrated this capability — it exists only at MFC.

Why it's important: Americium is a rare and expensive element that is used in small quantities in many types of household smoke detectors and geological data-gathering equipment. The roughly 2 grams purified at MFC is enough to build more than 7 million smoke detectors.

The next step: Studies of the pure metal will fill in knowledge gaps about its fundamental properties which will be important for studying alloys related to nuclear fuels. Such work helps researchers better understand the physical properties of fuels containing americium. This will ultimately lead to the understanding of how much americium can be in a transmutation fuel. Transmutation fuels have the potential to consume the americium and other highly radioactive fission product elements to make energy, thereby reducing the volume and toxicity of material destined for repositories.

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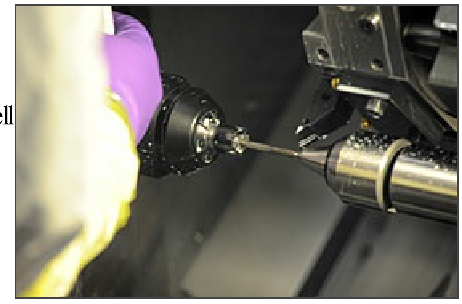
Glovebox Advanced Casting System furnace
What's new: A furnace that can melt and cast uranium, zirconium, plutonium, americium and neptunium fuels on a scale larger than any previous furnace has completed operational checks in the MFC Casting Lab. The new Glovebox Advanced Casting System (GACS) increases casting efficiency, melting control and casting control, and produces less radiological waste because the mold is not replaced with every casting.

How it's unique: The GACS furnace employs a distinctive fuel fabrication method which uses gravity to pour molten fuel alloys into a permanent, reusable mold. This process also produces less radiological waste.

Why it's important: Not only will the GACS furnace produce fuels for current experimental needs, it also will be used to assess the volatility of certain elements used in some advanced transmutation fuels.

The next step: The team is currently working toward casting the first new fuel samples. They hope to use the furnace to assess volatilization of fuel constituents such as americium during the casting process. This work can help evaluate future fuel cycle options.

Machining uranium
What's new: The very first direct machining of uranium metal at MFC happened when R&D technician Mike Chapple recently fabricated a small section of depleted uranium rod. Direct machining on metallic uranium establishes an ability to accelerate the fuel fabrication process, as well as to create new fuel types for experiments.



Direct machining of uranium metal enables acceleration of fuel fabrication process and creation of new fuel types for experiments.

How it's unique: Since the first steps were taken on depleted uranium, MFC operators have advanced to work directly on enriched metallic uranium to rapidly make precision experimental fuels.

Why it's important: This new capability greatly increases the efficiency and flexibility of fabricating high-precision metallic fuels for nuclear research and development experiments, while reducing the time needed and the amount of waste generated during the process.

The next step: Now that much of the fine-tuning of the tooling, lathe speeds and feed pressure needed to work on high-density metals like uranium is completed, the team has progressed to fabricating high-precision metallic fuel samples made of enriched uranium to test new fuel shapes and expand the research options available to DOE and industry customers.

Multi-Collector Inductively Coupled Plasma Mass Spectrometer
What it does: This device can detect almost any element (along with its isotopes) on the periodic table. The machine — dubbed the "Multi-Collector" by the research and operations team at MFC's Analytical Lab — provides ultra-precise measurements of isotopic ratios.

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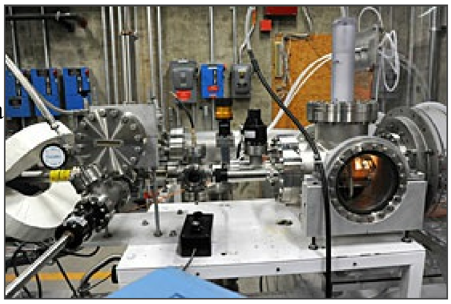
How it's unique: The Multi-Collector provides a faster and more accurate method to determine how much of which elements and isotopes are present in a sample, representing a leap above the DOE and industry standard for accurate measurements of isotopic ratios.

Why it's important: The Multi-Collector can help researchers determine whether advanced nuclear fuels or materials meet goals for safety, reliability and waste management. These analyses can inform decisions about future experiments that will lead to safer fuel designs with reduced waste.

The next step: The Analytical Lab has finished startup testing with nonirradiated samples and will soon begin measurements using irradiated samples.

Radioactive Mass Separator
What's new: MFC's Radioactive Mass Separator successfully completed its first operability testing in MFC's Analytical Lab. This technology can purify samples of different radioactive elements at the isotopic level. Such purification allows researchers to separate isotopes across a broad mass range, including the heavier actinide elements.

How it's unique: MFC has the only Mass Separator set up to work with radioactive elements — a research capability available nowhere else in the United States.



The Radioactive Mass Separator can purify samples of different radioactive elements at the isotopic level.

Why it's important: The mass separator transforms a sample containing a mixture of isotopes into a series of pure isotopes according to atomic mass. Afterward, the purity and quantity of each isolated sample is verified and characterized. These purified isotopes can then be used to support a wide range of nuclear research and development activities.

The next step: The lab is currently testing stable isotopes before beginning "hot" operation to introduce radioactive isotopes.

Irradiated Materials Characterization Laboratory
What it does: The recently-completed IMCL will improve the safety, quality and efficiency of post-irradiation examination research at MFC. The first research equipment to be placed in IMCL's 8,000-square-foot research area is the Shielded

Sample Preparation Area hot cell, which will provide a shielded environment to prepare irradiated samples for examination in electron microscopes and other scientific instruments within a new research facility.

How it's unique: The 12,000-square-foot multipurpose research facility will be equipped with a suite of high-tech research equipment and hot cells. The facility will be a test bed for developing advanced characterization techniques for irradiated materials.

Why it's important: The flexible, state-of-the-art IMCL will house extremely sensitive research equipment needed to examine advanced nuclear fuel and material samples after irradiation. The building is isolated from vibration, electromagnetic interference and temperature swings to support the highest possible quality of research for DOE and other users. Lessons learned from activities can then be used for design of future advanced capabilities.

The next step: Additional post-irradiation examination research tools, including optical and electron microscopes and materials testing equipment, will be installed and tested in the facility in the coming years.

(Posted Aug. 5, 2013)

Feature Archive